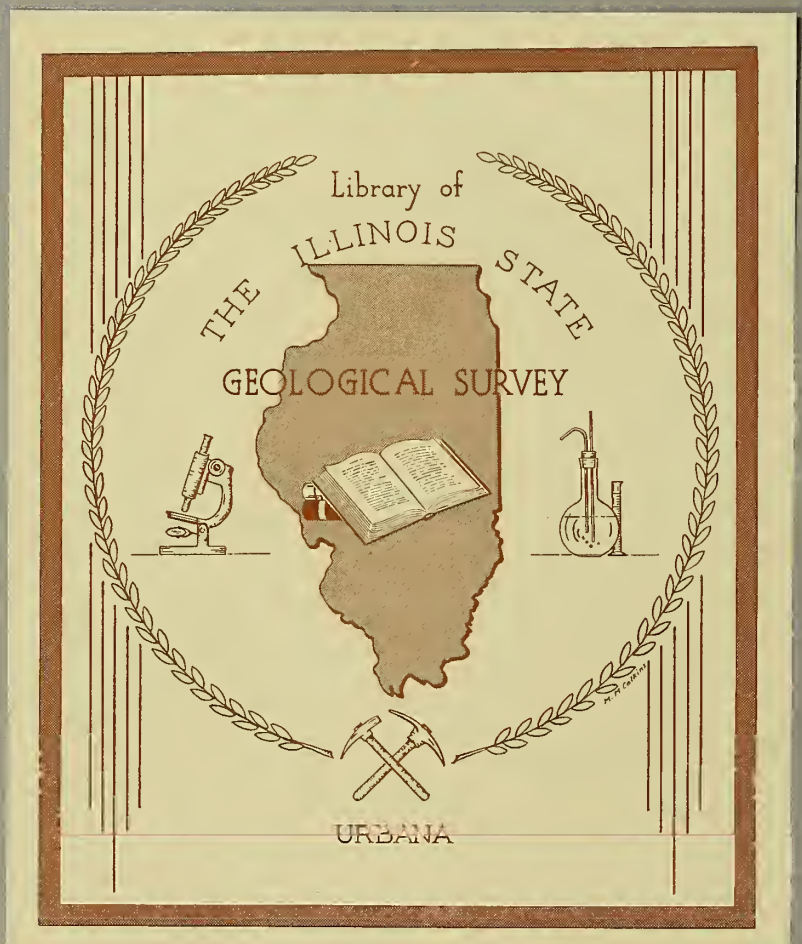

State of Illinois
Henry Horner, Governor
Department of Registration and Education
Division of the
STATE GEOLOGICAL SURVEY
M. M. Leighton, Chief
Urbana

INFORMATION CIRCULAR NO. 10

ABSTRACTS OF PAPERS DEALING WITH COAL

Presented at the

THIRD ANNUAL MINERAL INDUSTRIES CONFERENCE
OF ILLINOIS
May 17-18, 1935

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Illinois' Position as the Keystone Mineral State of the Upper Mississippi Valley - M. M. Leighton

Developments in the Technology of Illinois Fuel - Samuel R. Lewis

The Viewpoint of Science in the Production and Utilization of Coal - Frank H. Reed

The Economics of Coal Beneficiation with Special Reference to the Problems of the Small Operator - R. J. Lawry

Possibilities of Improving and Extending the Use of Illinois Coals through the Study of their Constitution - Gilbert H. Cady

Utilization of Coal Mine Wastes - C. M. Smith

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Illinois Coal as a Source of Gaseous and Liquid Fuels, Looking to the Not Far Distant Future - From the Viewpoint of a Technical Man in Industry - M. D. Curran

Illinois Coal as a Source of Gaseous and Liquid Fuels, Looking to the Not Far Distant Future - From the Viewpoint of a Research Coal Chemist - Gilbert Thiessen

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August, 1935

INTRODUCTORY NOTE

The Third Annual Mineral Industries Conference of Illinois, sponsored by the Illinois State Geological Survey and the Engineering Experiment Station of the University of Illinois, held at Urbana on May 17 and 18, had as its theme "Trends in the Utilization of Mineral Products". The conference gave particular attention to the coal industry, and many points of interest to this industry were brought out in the various papers and the discussions which followed them. In order that interested individuals who could not arrange to attend the meetings may know of these points, these abstracts have been prepared, giving attention only to that part of the conference devoted to coal. It is hoped that arrangements can be made whereby the complete papers may be published. The Survey does not assume responsibility for the statements here presented.

GENERAL SESSION

Illinois' Position as the Keystone Mineral State of the Upper Mississippi Valley, by M. M. Leighton, Chief, Illinois State Geological Survey. Dr. Leighton pointed out that Illinois, with its resources of fuel, clay, shale, building stone, limestone, sand, gravel, fluorspar, etc., has always been a leading mineral producer. By pointing out two facts, first that our modern civilization and its high standards of living demand minerals and therefore the use of minerals will continue, and second that science has developed so rapidly in recent years that the utilization of minerals has undergone rapid change, Dr. Leighton was able to emphasize the absolute necessity that individuals active in industry keep in close touch with modern scientific research on mineral products in order to keep abreast of developments and thereby protect their investments. These factors led him to emphasize the way in which scientific research on Illinois raw material is tending to extend their use by developing new products or improving old ones. Specific examples were given. By means of such research, the leading position of Illinois as a mineral producing state should be retained.

Developments in the Technology of Illinois Fuel, by Samuel R. Lewis, Consulting Mechanical Engineer, Chicago. The outstanding developments in coal technology in Illinois relate to better preparation, including cleaning, better sizing, dedusting, and oil or other treatments to lay dust. Oil-treated coal raises no dust when handled, and is therefore very desirable from the standpoint of the small consumer. Washed coal increases the efficiency of combustion

and is more desirable because of its lower ash content. Mechanical firing devices, together with automatic combustion controls are coming into much wider use. Better understanding of the principles of combustion have led to better furnace design and have greatly decreased the number of unsatisfactory installations; especially is there a tendency to install equipment of adequate capacity. There has been a revival of the spreader type of stoker. The power requirements are small, the mechanism simple, but the spreader stoker is better adapted to steady loads than to operations where rapid fluctuations in demand occur. Use of the small coal stoker for domestic heating installations is increasing, but much improvement is needed in the design of the boilers. Domestic heating installations need to be completely unified installations. The proposal to build a central steam generating plant in the Chicago loop is not sound, since there is already sufficient steam generating capacity, which, if modernized, would more efficiently serve the same purpose.

The Viewpoint of Science in the Production and Utilization of Coal, by Frank H. Reed, Chief Chemist, State Geological Survey. Scientific research is the orderly method by which the physical and chemical laws of the universe are learned. Industrial or applied research is the unbiased method of applying fundamental scientific information to the solution of purely utilitarian problems. Industry has found applied research profitable when correctly used. Applied research is dependent upon fundamental research and can progress only if a body of fundamental information is kept ahead of it. An example of an industry entirely dependent upon research for its existence in the United States is the synthetic dye and organic chemical industry. Many of the organizations engaged in this industry have seen the necessity for, and are engaging in fundamental research. The industrial research fellowship plan of the Mellon Institute, due to R. K. Duncan, was an important development. In recent years, we have seen the rapid introduction and growth of federal and state laboratories, and laboratories financed by trade groups, such as that of the American Gas Association. It seems highly improbable that coal will find extensive use other than as a fuel or source of power. Research should be directed towards the most efficient and economical utilization of coal, which means a more fundamental understanding of the nature of coal and its components, and the nature of coal combustion. Also, fundamental research is needed for complete solutions of the problems arising in the transformation of coal into coke and into liquid and gaseous fuels.

EXHIBITS AND DEMONSTRATIONS

Demonstration of Smokeless Briquetting, R. J. Piersol, Physicist, State Geological Survey. Smokeless briquets were produced from 45-gram samples of dry 4-mesh St. Clair County coal which was partially prevolatilized by heating in a rotary furnace for a 5-minute period up to a coal temperature of about 500°C. The volatile loss was 15 per cent, the resultant product being smokeless. The coal, in its container, was removed from the furnace, cooled to about 300°C., transferred to the impact die maintained at that temperature and impacted by the blow of a 500-pound hammer dropped from a 4-foot height. The resultant briquet is 1.5 inches in diameter and 1.2 inches high.

Smokeless briquets of larger size were also shown. These weigh 2 pounds, being 4 inches in diameter and 4 inches high. They were made in a commercial development plant by the same process. The required impact blow was that from a 2-ton hammer dropped from a 10-foot height.

Small pieces broken from smokeless briquets and from corresponding natural coal were placed separately on two steel plates, maintained at red heat. The smokeless briquet burned without any appreciable evolution of smoke. The combustion was from the outside inward, forming a glowing mass without swelling or cracking. The natural coal burned with the customary smoking, cracking and swelling.

The smokeless briquet and the corresponding coal ignited with equal ease, due to the high remaining volatile content in smokeless briquets. This contrasts with the difficulty of igniting coke.

The strength of briquets impacted without binder is much greater than that of the corresponding natural coals as determined by tumbling loss. Also briquets are free from parting planes which cause the cracking of natural coals.

The density of briquets impacted without binder is greater than that of corresponding natural coals due to the loss in pore space. Therefore, such briquets absorb less water than do the corresponding natural coals upon alternate wetting and drying. This accounts for the briquets' remarkable resistance to weathering.

Demonstrations on Coke and Gas-making Properties of Illinois Coals, Gilbert Thiessen, Associate Chemist, State Geological Survey. Various pieces of equipment used in the laboratory study of the coking properties of Illinois coals were set up and operating, others were on display.

Apparatus for determining the temperature range during which coal is plastic and the amount of swelling or shrinking which the coal undergoes while in its plastic condition was in operation. A recording potentiometer pyrometer was used to record automatically the temperature of the coal during the test.

For demonstrating the method of studying coke and the behavior of the coal ingredients during coking, coke sections prepared according to the method of H. J. Rose for showing the detailed structure were on display and available for examination under a microscope.

Two types of apparatus for separating coal components by electrostatic forces using high electrical potentials were in operation. The separation is based upon the differences in dielectric constants of the components, and on the fact that fusain has a much larger surface area per unit of weight than do other coal components, and therefore absorbs a larger electrical charge.

Other equipment such as that used by the U. S. Steel Company's method for estimating gas, coke, and tar yields of coal, and the equipment for determining the caking value of coal, were discussed.

Microscopic Study of Coal, W. S. McCabe and C. G. Ball, Assistant Geologists, State Geological Survey. The microscopic studies of coal are concerned with the physical character and properties of the individual constituents that enter into coal, thus providing a basis for an understanding of the fundamental physical and chemical character of coal out of which new possibilities of usefulness will arise.

The laboratory devoted to these investigations had a group of exhibits showing the method of preparing the coal for study. The process of making thin sections was demonstrated, and the appearance of the coal, showing its woody nature, and the spores and cuticular material was illustrated by the use of the microscope. Polished surfaces of coal, etched to bring out in relief minute plant structures, were available for microscopic inspection. The process of maceration and the spores and cuticles obtained by this process were respectively explained and exhibited.

The method of study of mineral matter in coal was demonstrated. Opportunity was given to observe the occurrence of thin typical minerals, calcite, kaolinite, and pyrite, in thin-section and in coal blocks, and charts showing the variation in the distribution of these minerals in No. 6 coal bed were on display. The effect of preparation in separation and concentration of the banded ingredients of coal - vitrain, clarain, and fusain - was shown by an exhibit of several size fractions of coal obtained from a sample of 1 1/4-inch screenings showing the tendency for concentration of vitrain in certain of the small sizes and fusain in others.

The general purpose of the exhibit was to indicate the processes and technique of preparation and study of the physical nature of coal and also to give the visitors an understanding of the physical make-up of coal and an insight into the possibilities of obtaining a more correct understanding of its nature.

EVENING ADDRESS

One of the high points of the meetings was the address by Dr. John W. Finch, Director of the U. S. Bureau of Mines, which followed the annual conference dinner. Dr. Finch pointed out that minerals are more necessary to the life and well-being of people than most persons realize. Not only are minerals necessary for progress and for comfortable human existence, but mining carries a large burden of responsibility for the welfare of the community. He said that the chief causes of trouble in the mineral industry today, over-production and unemployment, have their seeds in the World War andnot in the depression. The period of inflation and over-production following the war necessitated a period of readjustment that has not yet been accomplished. According to Dr. Finch, the committee appointed by the President to study causes of maladjustment and unemployment in the industry and to recommend means of improvement had recommended that the government allow the various groups in the industry to attempt to work out their own affairs, and that all other expedients would be tried before that of government control.

SYMPOSIUM ON COAL

On Saturday morning, May 18, a symposium of six timely papers on "Trends in Technology and Research" was presented before an audience including representatives of the coal industry of the State. Abstracts of the papers presented at the Saturday morning session follow.

The Economics of Coal Beneficiation With Special Reference to the Problems of the Small Operator, by R. G. Lawry, Contracting Engineer, Roberts and Schaefer Company, Chicago. The Illinois coal industry is alive to the present-day demand for a well-prepared fuel by an increasingly better-informed buying public. About nine-tenths of the annual output of coal is produced by half the mines, the remaining one-tenth by an equal number of much smaller mines. Mechanical coal-cleaning plants are not feasible at many of these mines because of their small outputs. There are few cleaning plants at mines producing less than from 500 to 1000 tons of coal per day, although coal preparation is just as important to these mines as it is to the large ones. Hand picking, and some sizing, will be all that local or wagon mines will be able to afford. Central cleaning plants for a number of small mines under the same ownership have not, in the past, worked out well, and central cleaning plants for small mines under different ownership are not recommended. Two alternatives are presented for the medium sized mine: a group of such mines may be combined under a holding company, which would finance and operate the cleaning plant and sell the product; or, if the mine is large enough, install a cleaning plant designed especially for economical operation at low rates. Consolidation of mines under a holding com-

pany should be carried out only under the guidance and according to the recommendations of an experienced and qualified engineering organization. Only such mines should be included in the group as will add to the ultimate success of the combination.

Possibilities of Improving and Extending the Use of Illinois Coals through the Study of Their Constitution, by Gilbert H. Cady, Senior Geologist and Head of the Coal Division, State Geological Survey. As a material whose use is primarily for direct combustion, coal is commonly evaluated and described solely in terms of its combustible and incombustible contents. This tendency has produced the generalized commercial forms of analysis. From the naturalistic point of view, coal is a conglomerate of differently coalified plant materials, each with more or less definite chemical characteristics. With such an understanding of the nature of coal, efficient utilization appears to require not merely mechanically perfect combustion procedure but also a knowledge of the properties of the individual constituents and of the possibility of their separation and concentration for special uses.

The banded character of Illinois coals is their outstanding physical characteristic. The four banded ingredients are vitrain, the brilliant jet-black coal; clarain, the bright laminated coal which makes up the bulk of the Illinois coal beds; fusain, or mineral charcoal; and, rarely, splint coal, or durain. The banded ingredients show considerable differences in their chemical characteristics and differ physically in other ways than in appearance, such as in specific gravity and friability, so that there tends to be a separation and concentration of different ingredients in different sizes during the preparation process. This provides a possibility of control over the petrographic constitution of the coal supplied to the market for special uses, such as coking, gasification, hydrogenation, and for use as powdered coal.

Studies in coal constitution have also provided new information in regard to the character and occurrence of mineral matter in coal. About 98 per cent of the separable mineral matter in Illinois coal is composed of pyrites, calcite, kaolinite, and detrital clay, while a considerable proportion of the remaining two per cent is silica.

Utilization of Coal Mine Wastes, by C. M. Smith, Research Assistant Professor of Mining Engineering, University of Illinois. Many inquiries concerning possibilities of procuring pyrite suitable for sulfuric acid manufacture from coal mine wastes led to a study of the means of utilizing these wastes. A preliminary field study was not encouraging from the standpoint of pyrite recovery, but did show that a thorough investigation of the feasibility of recovering coal alone was warranted. As yet, only the problem of utilizing table pickings has been studied. Representative samples were taken of

the picking table refuse at seven mines, of which five used mechanical loading, one hand loading, and one was a strip mine. The samples of a ton or more were sent to the laboratory in Urbana and crushed in a gyratory crusher to minus 1 1/2 inch to liberate the coal and to facilitate testing. By screening, three sizes were prepared: 1 1/2 by 3/4 inch, corresponding to small nut, 3/4 by 3/16, or stoker size, and 3/16 by 65-mesh. The minus 65-mesh material was small in amount and was not tested. The other sizes were subjected to float-and-sink separation to yield a clean coal fraction of less than 1.40 specific gravity; a middlings or mine boiler fuel fraction of 1.40 to 1.60 specific gravity; and a refuse fraction of greater than 1.60 specific gravity. The clean coal content of the samples averaged 37 per cent, ranging from 24 to 51 per cent. One half the crushed sample, roughly, was small nut; 40 per cent, stoker size; and the rest, fines. For the nut size, the content of clean coal ranged from 17 to 44 per cent, while for the fines, the range was from 35 to 64 per cent. In the one sample for which a complete analysis is known, the greatest concentration of sulfur (27.4 per cent) was found in the refuse from small nut size; the sulfur content of the composite refuse was 23.7 per cent. While considerable tonnages of pyrite could be recovered by further crushing and concentrating, it does not seem to be commercially advantageous because of the high cost of producing pyrite of sufficient purity to meet specifications, and the low prices offered for the concentrate. On the other hand, the investigation has shown that thousands of tons of clean coal are annually being wasted in the form of table pickings at Illinois coal mines. Indications are that most of this valuable waste material could be recovered at a profit.

Selection and Design of Equipment for Burning Illinois Coals, by Henry Kreisinger, Combustion Engineering Company, Inc., New York City. This paper presents the fact that the traveling grate stoker is best suited for burning Illinois coal. The gases rising from the fuel bed on the front part of the chain grate stoker contain large quantities of combustible matter. This combustible matter must be mixed with air, otherwise smoke is produced. Oxygen does not come through the fuel bed unless there are holes in it. Air must be admitted around or over the fuel bed and mixed with the gases from the fuel bed to complete combustion. By constructing the furnace with a long rear arch, a short front arch, and a narrow throat, this mixingcan be made to take place with resultant complete burning of combustible in the gas. These arches are usually water-cooled. When burning Illinois coal, it is desirable that the side walls and throat also be water-cooled. Traveling grate stokers are used for units generating 10,000 to 100,000 pounds of steam per hour. For smaller units, the Type E or the spreading stoker are used. For larger units, the stoker becomes too large, and powdered coal firing should be used for which Illinois coal is well suited. Flame travel must be designed to prevent

pasty fly ash from getting to the boiler tubes. Combustion space for pulverized fuel must be at least double the size when combustion takes place in the fuel bed. Water-cooled furnaces are recommended when Illinois coals are burned by this method. Illinois coals are well adapted for slag-tap furnaces, since then advantage can be taken of the low ash-softening temperatures of these coals. The hardness and ash content of Illinois coals will decrease the capacities and increase the maintenance costs of all types of pulverizing equipment. Maintenance is higher with high speed hammer mills than with low speed roller, or ball mills, which should therefore be given preference when selecting mills for pulverizing Illinois coal.

Illinois Coal as a Source of Gaseous and Liquid Fuel - Looking to the Not-Far-Distant Future - From the Viewpoint of a Technical Man in Industry, by M. D. Curran, President, Radiant Fuel Corporation, St. Louis and West Frankfort. Gas and oil produced from coal in the United States has largely been a by-product of the manufacture of metallurgical coke. Because of the high price of coke during and after the war, artificial gas plants in the Illinois coal trade territory changed from coke to coal as a water-gas fuel. This created a considerable demand for Illinois coal. In recent years, much of the coal used in the production of producer gas has been replaced by natural gas. Illinois coal has not been found satisfactory for the production of metallurgical coke, but very satisfactory domestic coke is being made from it. It has been found that in order to make domestic smokeless fuel successfully from Illinois coals, the following conditions must be satisfied. Free moisture must first be disposed of, a fuel with low combustion temperature must be produced to minimize clinkering troubles, which are greater with coke than with coal, the process must be simple, flexible, capable of using screenings, of low capital cost, and suitable for operation at the mine. A plant meeting these conditions has been in operation at West Frankfort for about a year and a half, coking about 100 tons of coal per day. In the manufacture of coke, it is important to have an adequate outlet for the gas. Such outlets may be provided by running high-pressure gas lines from the ovens to the large centers of population. The production of domestic coke from Illinois coal will provide an outlet now filled by out-of-state coal.

Illinois Coal as a Source of Gaseous and Liquid Fuels, Looking to the Not-Far-Distant Future - From the Viewpoint of a Research Coal Chemist, by Gilbert Thiessen, Associate Chemist, State Geological Survey. Because of the rapid rate at which we are drawing upon our reserves of petroleum, a time can be seen in which we shall have to look to coal as a source of liquid fuel. In countries having no petroleum resources, liquid fuels are today being made from coal. It is technically possible to make such liquid fuels by several different processes. Those offering the greatest promise today are the recovery and refinement of the liquid products of coal carbonization, coal hydrogenation, and the synthesis of liquid fuels from gases made from coal or coke. The by-products of coal carbonization appear to

be able to supply but a small part of the demand. Hydrogenation processes are in large scale use in Germany, and large plants are being built in other countries, especially in England. The cost of gasoline from the hydrogenation process is today somewhat more than twice the refinery price of petroleum gasoline. Operation of present coal hydrogenation plants is possible only because of government subsidies. There are still many technical and engineering difficulties. Illinois coals are well suited to hydrogenation. Processes involving the synthesis of liquid fuels from coke oven or water-gas gases are not yet in large scale operation. They may operate either at high pressures, in which case only small volumes are handled, or at low pressures in which case the gas volumes are large. The most economic method of operation has not yet been determined. There are still many technical details to be solved.

The manufactured gas industry will continue to gain importance, and many new developments may be expected, especially in the decrease of cost of production and in the long distance transportation of manufactured gas.

Conducted concurrently with the symposium on "Illinois Coal: Its Future" were two symposia covering trends in technology and research in Clay and Clay Products and in Rock and Rock Products. Abstracts of the papers presented at these meetings may be obtained by addressing the Chief, Illinois State Geological Survey, Urbana, Illinois.